

Aquatic ecotoxicity testing of nanoplastics

lessons learned from nanoecotoxicology

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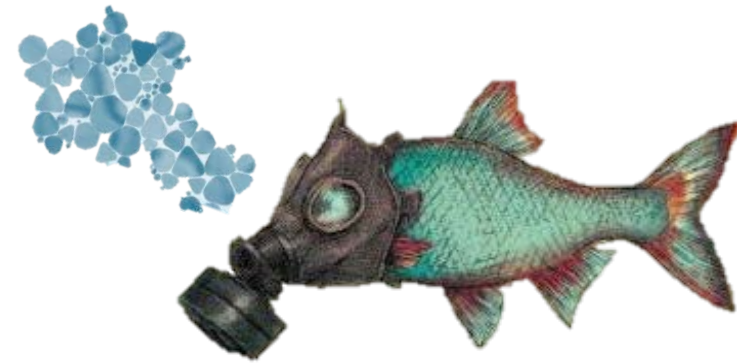
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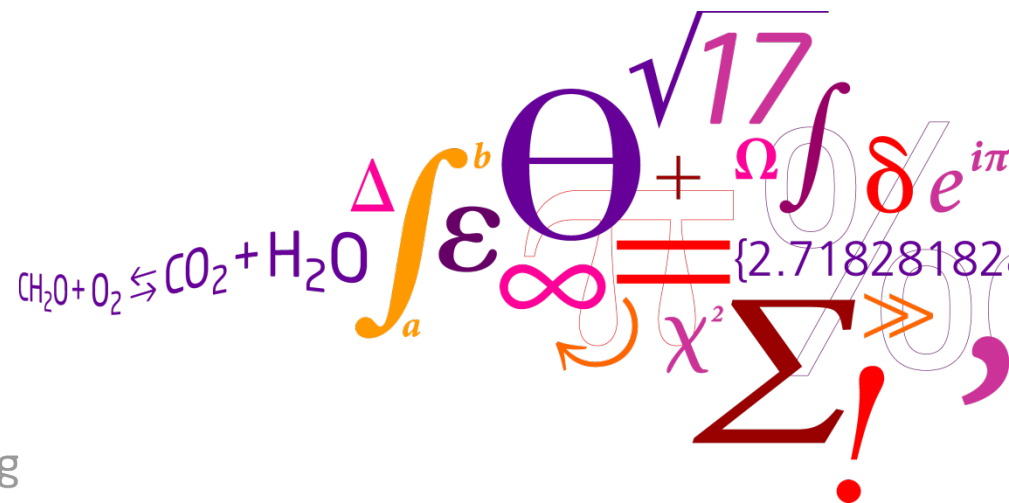
Aquatic Ecotoxicity Testing of Nanoplastics

Lessons learned from nanoecotoxicology

Nanna B. Hartmann, Tom Nolte, Mads A. Sørensen, Pernille R. Jensen, Anders Baun



*2015 Aquatic Sciences Meeting
27th February 2015, Granada, Spain*



The group

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- Associate professor Steffen Foss Hansen
- Senior Researcher
Hans-Christian Holten Lützhøft
- Postdoc Nanna Bloch Hartmann

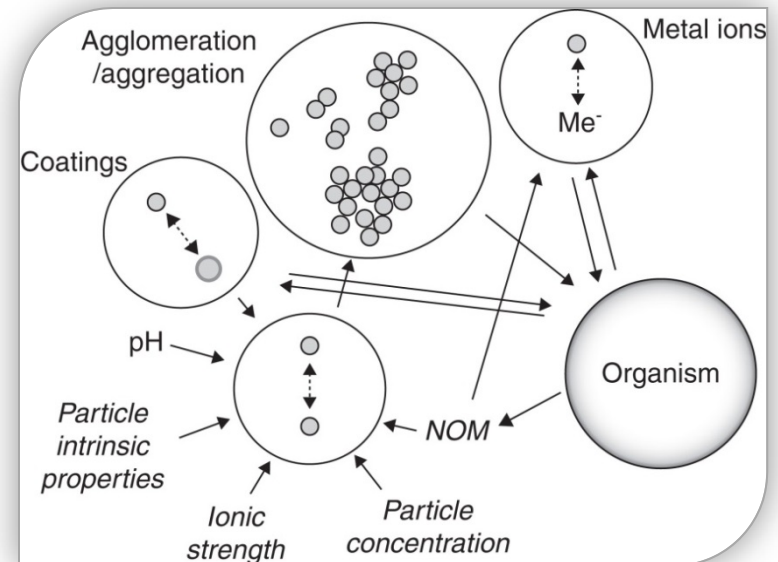
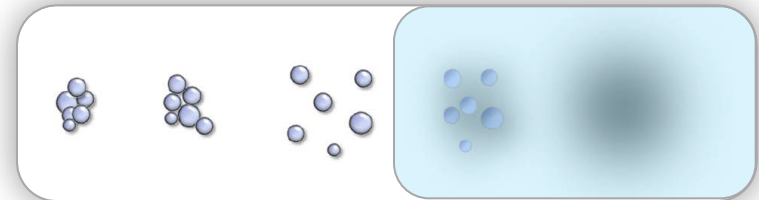
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 - Lars Michael Skjolding
 - Biase Liguri
 - Katrine Nielsen
 - Laura Heggelund
 - Aiga Mackevica
 - Rune Hjort



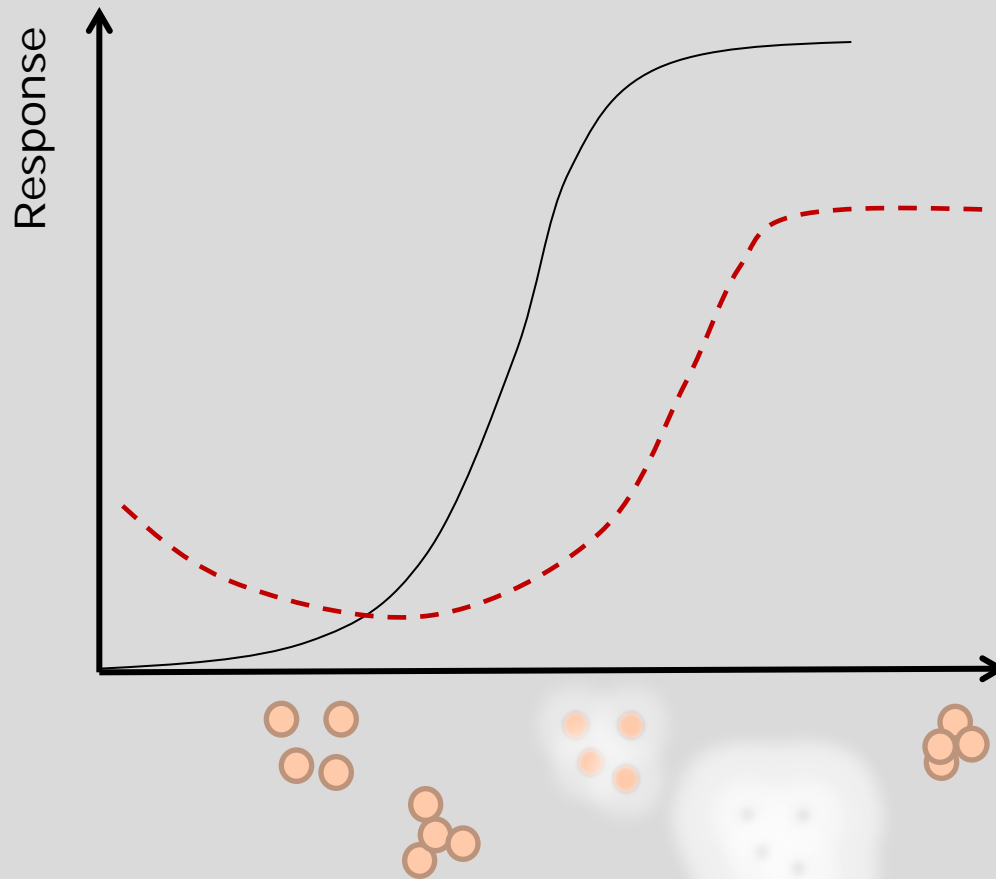
What do we do?



**New paradigm
for ecotoxicity
testing of NMs**
(European
Research Council
Starting Grant)



Dose-response testing with nanoparticles



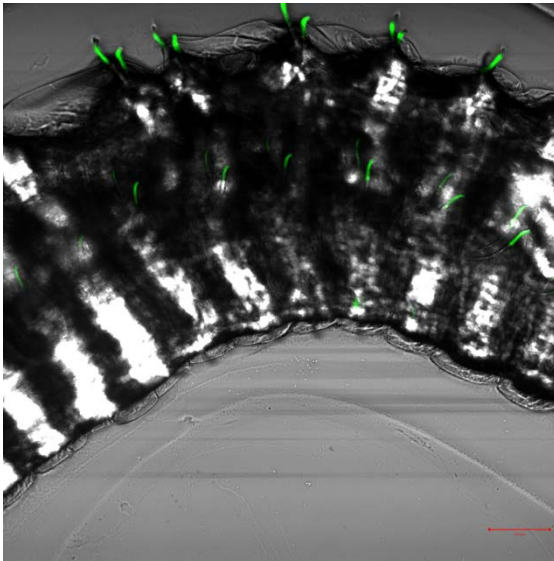
Dose?

Tuning the test system...

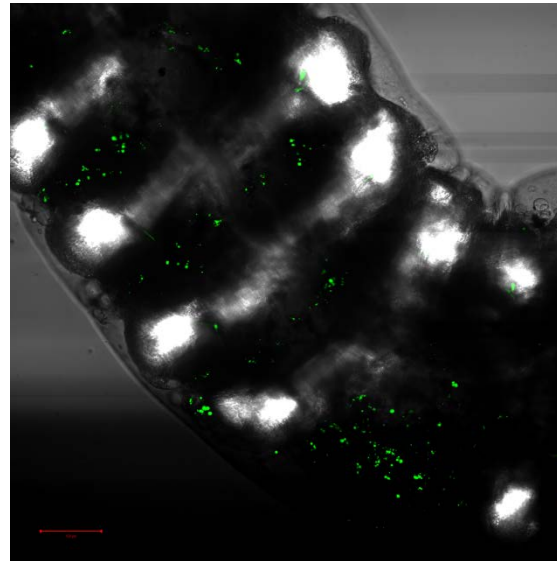


Plastic particles as model particles...

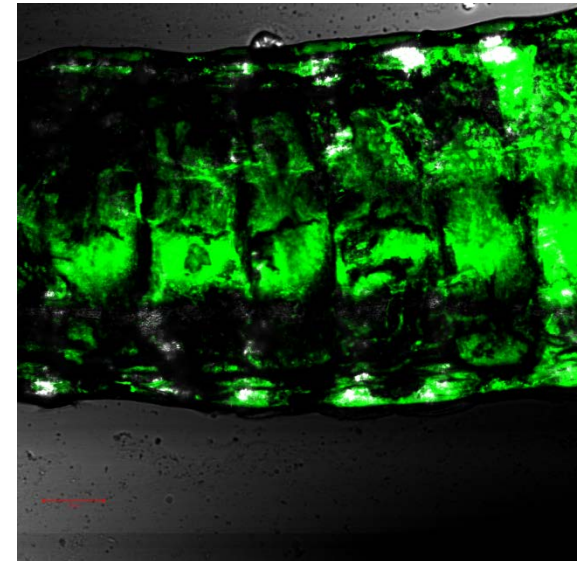
Lumbricus variegatus (freshwater sediment worm). Aquatic exposure to micro- and nanoplastics. Imaged by confocal microscopy



Control

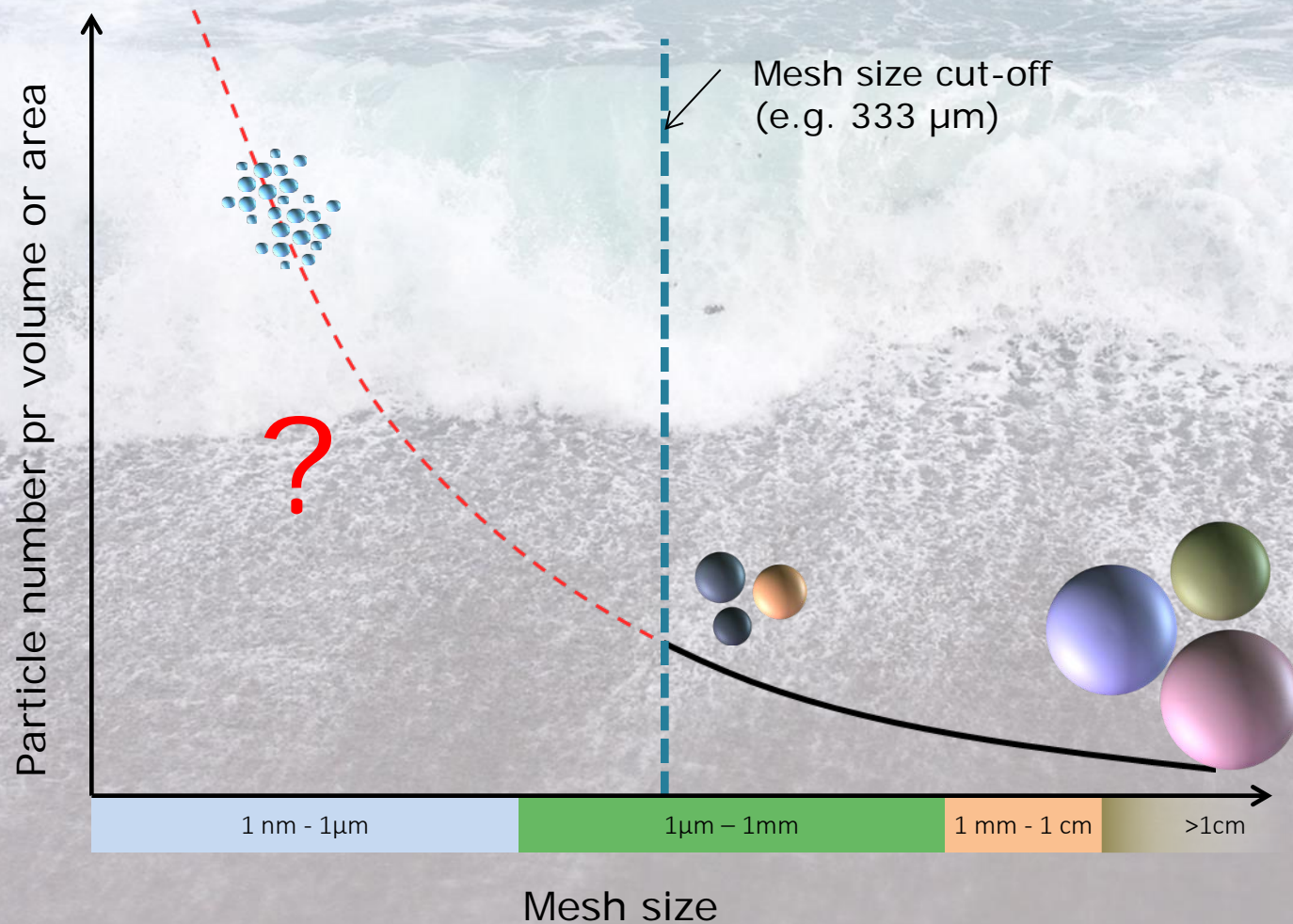


1 µm PS-COOH

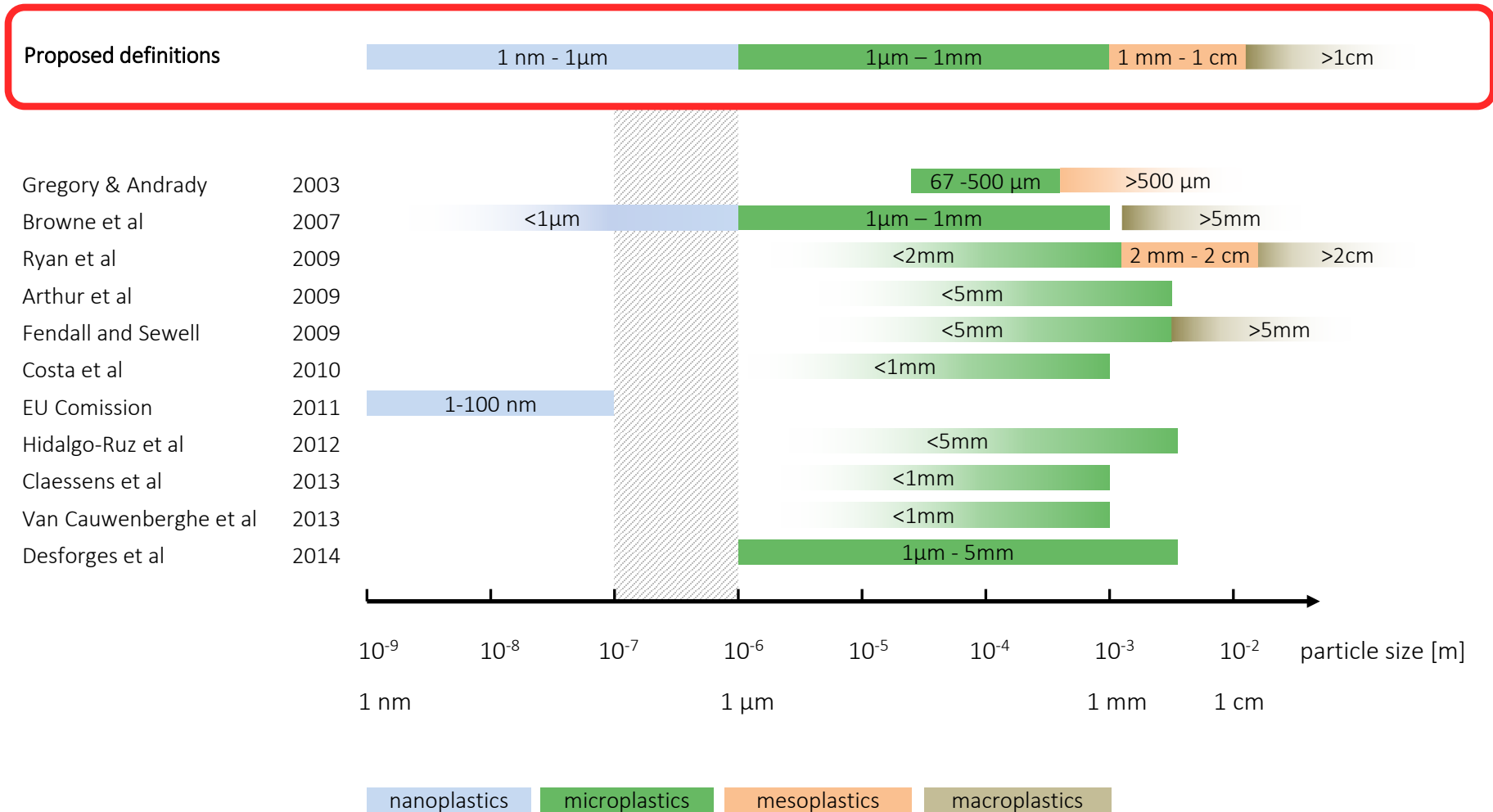


20 nm PS-COOH

Nanoplastics – an environmental problem?



Definition of nanoplastics



Some lessons learned from nanoecotoxicology...



Interactions between nanoparticles and algae (*P. subcapitata*) by transmission electron microscopy (TEM)

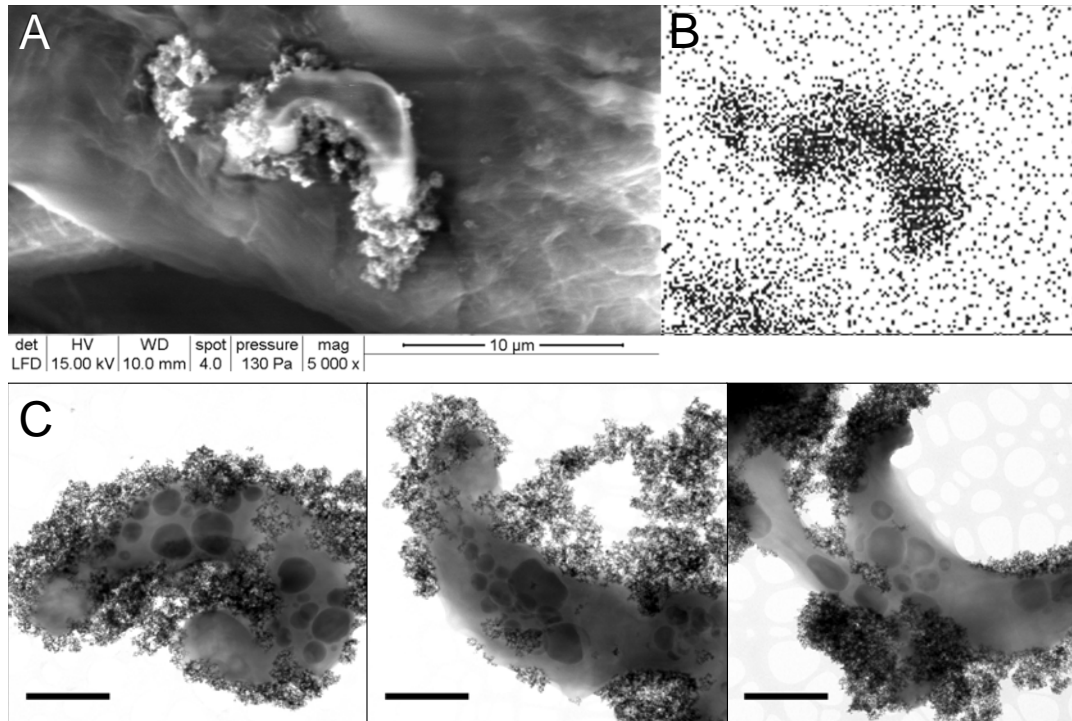
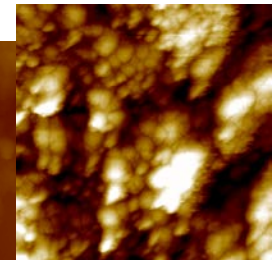
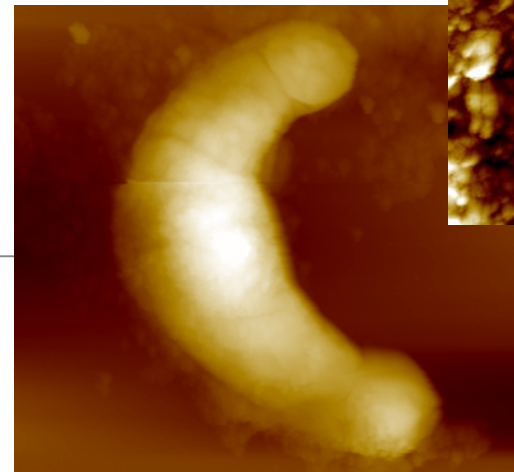
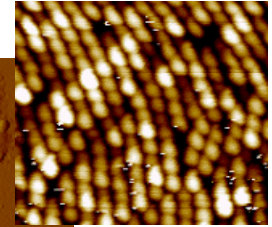
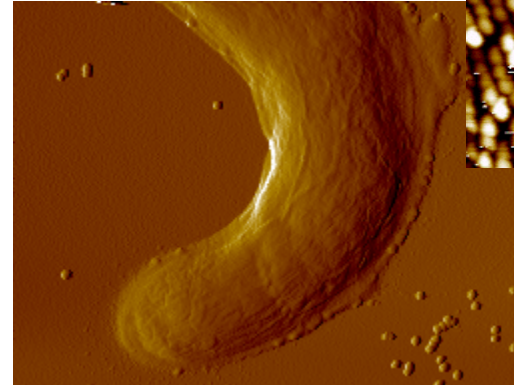
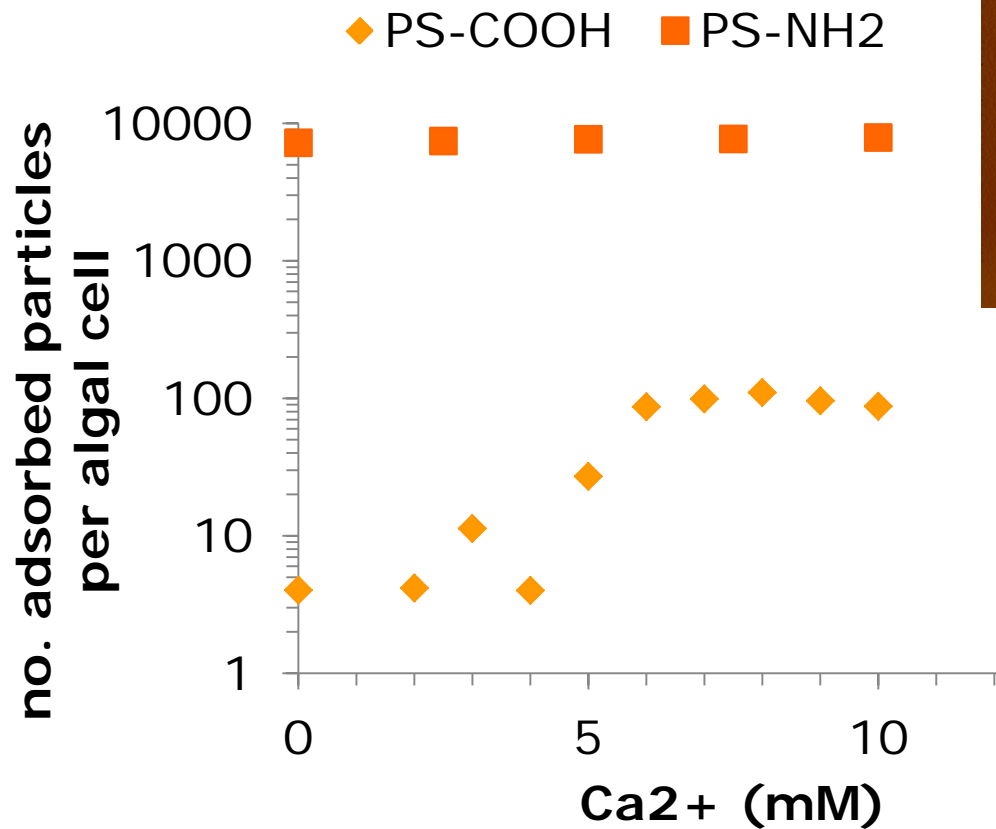
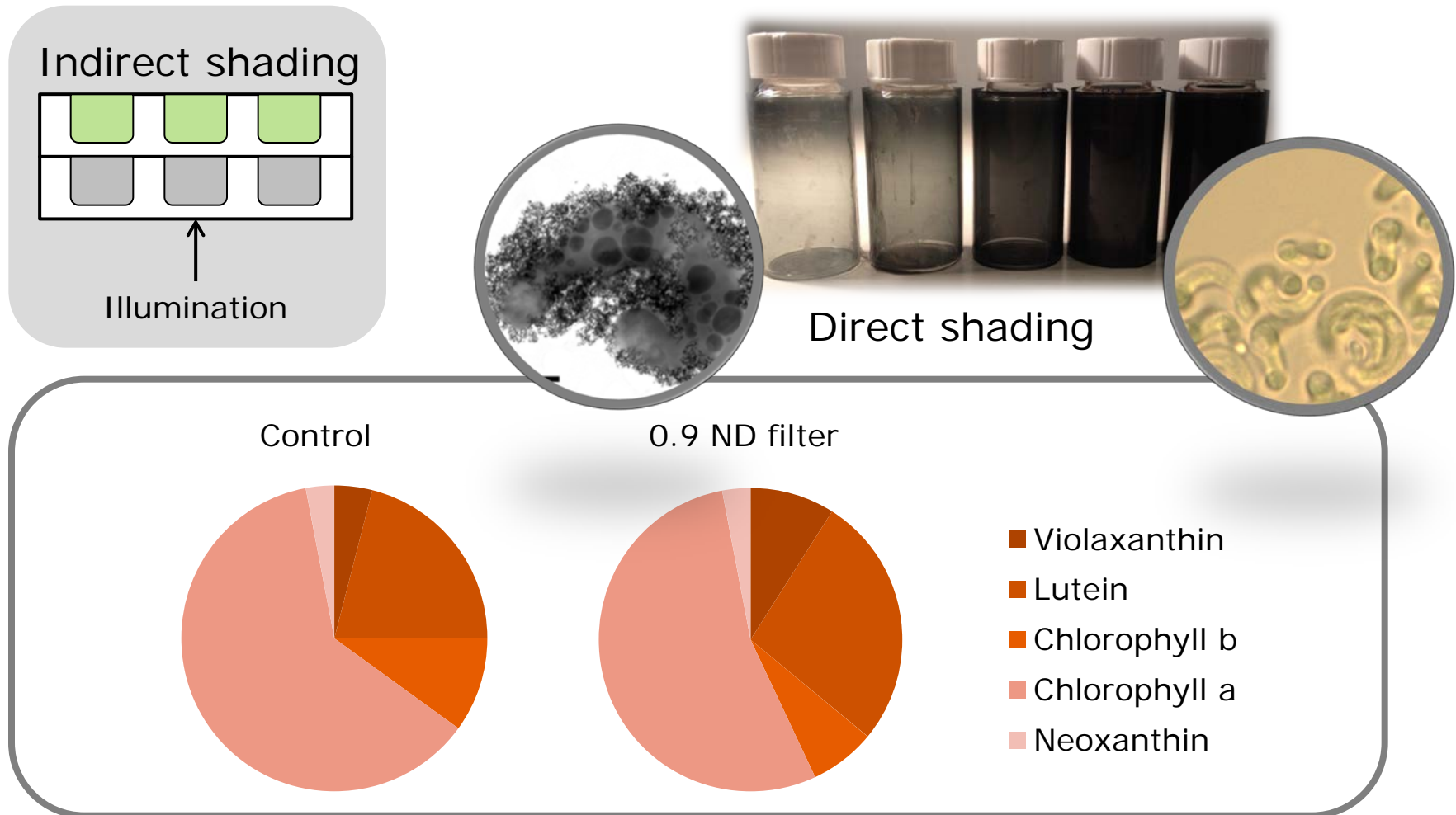


Figure 3. Encapsulation of algal cells (*Pseudokirchneriella subcapitata*) exposed to TiO₂ nanoparticles. A: Scanning electron microscopy (SEM) image of an algal cell after exposure to 50 mg/L TiO₂ in ISO algal test media for 48 h. B: Corresponding SEM-EDX dot map shows the distribution of Ti. It can be seen that the TiO₂ nanoparticles cover the surface of the algae (Modified from Hartmann et al., 2010 – Paper I). C: Transmission electron microscopy (TEM) images showing the formation of algae-particle heteroaggregates (scale bar: 2 μm). (Modified from Hartmann et al., 2011b – Paper IV)

Interactions between nanoplastics and algae cells (*P. subcapitata*) by UV-VIS spectroscopy and atomic force microscopy (AFM)



Are effects caused by shading?



Some lessons learned from nanoecotoxicology...



Uptake and depuration of PS beads in *D. magna*

Neonate *D. magna* (<24 h) exposed to 5 mg solids/L fluorescent polystyrene beads (20 nm). Imaged by Fluorescent Light Sheet Microscopy

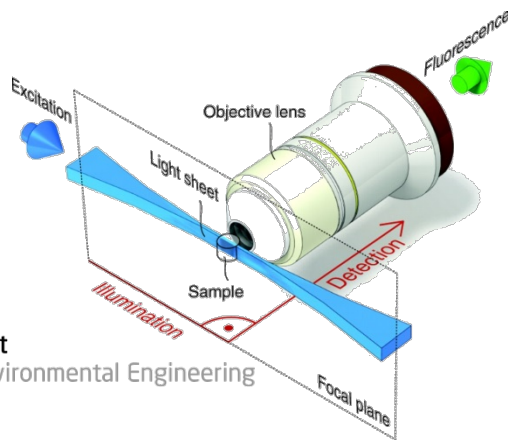
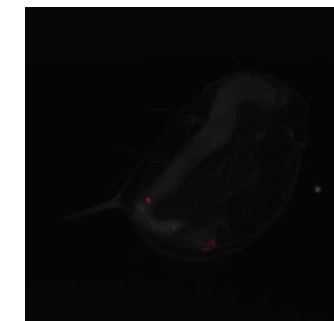
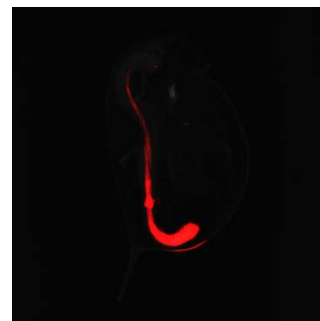
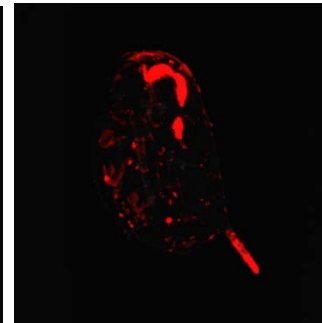
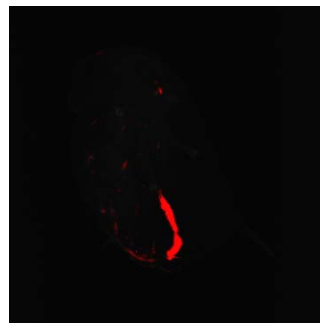
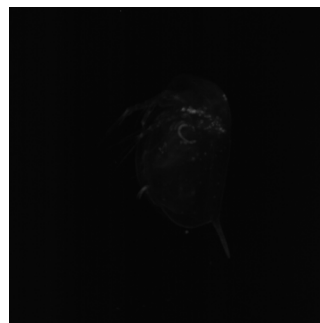
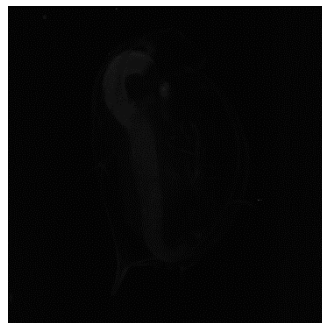
Control

1h

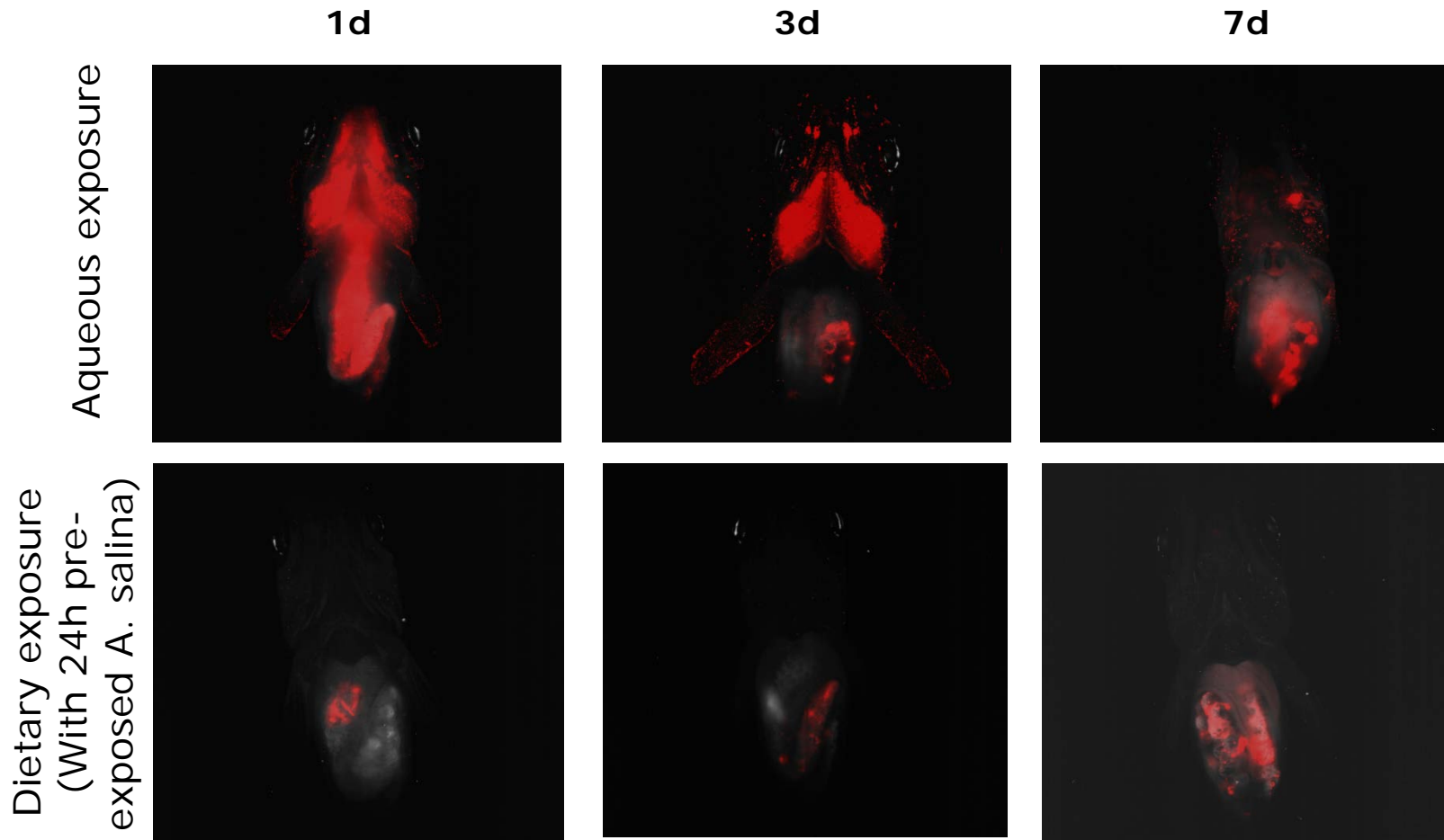
2h

4h

24h



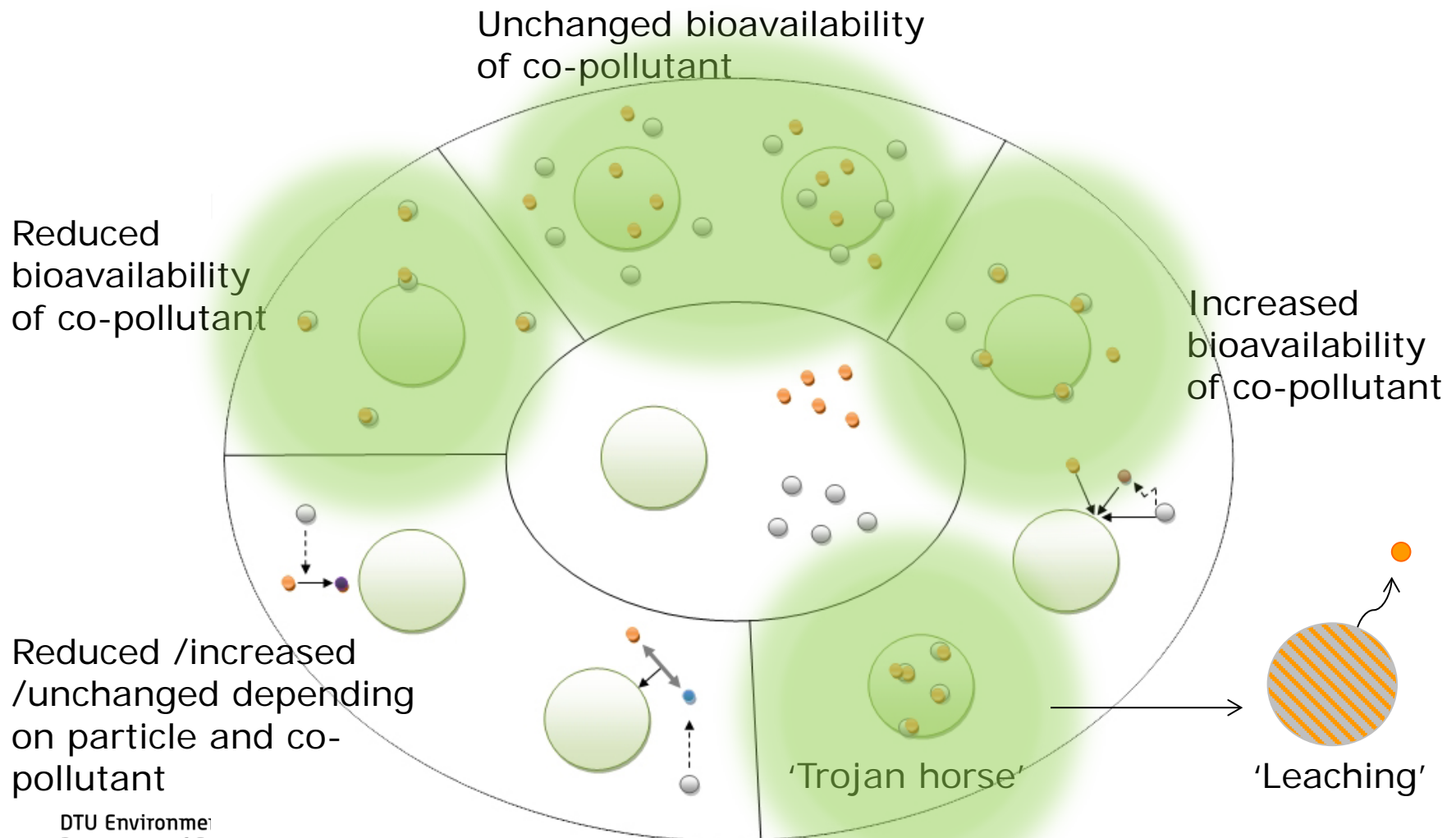
Uptake of PS beads in juvenile *D. rerio* – aqueous and dietary exposure



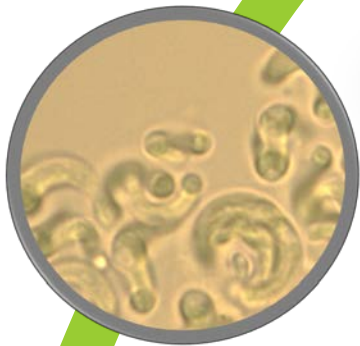
Some lessons learned from nanoecotoxicology...



Scenarios for particle interactions with co-pollutants



Some lessons learned from nanoecotoxicology...



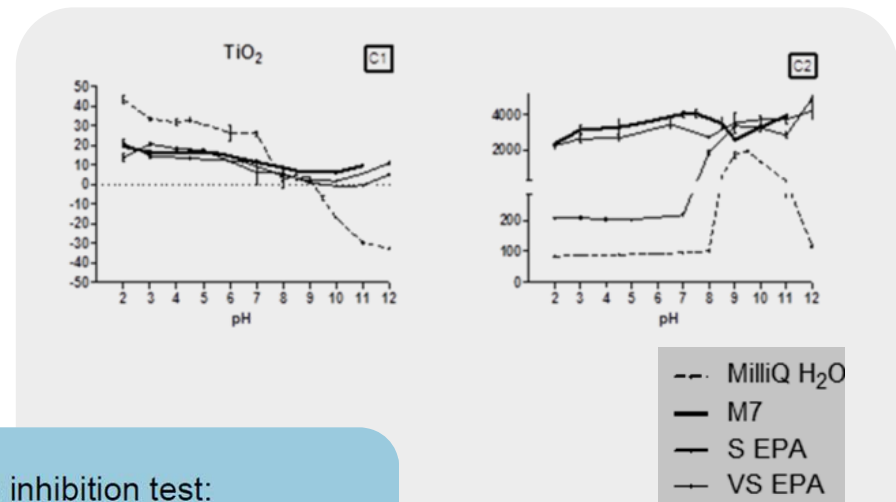
General test system considerations

- For meaningful dose-response testing we must:

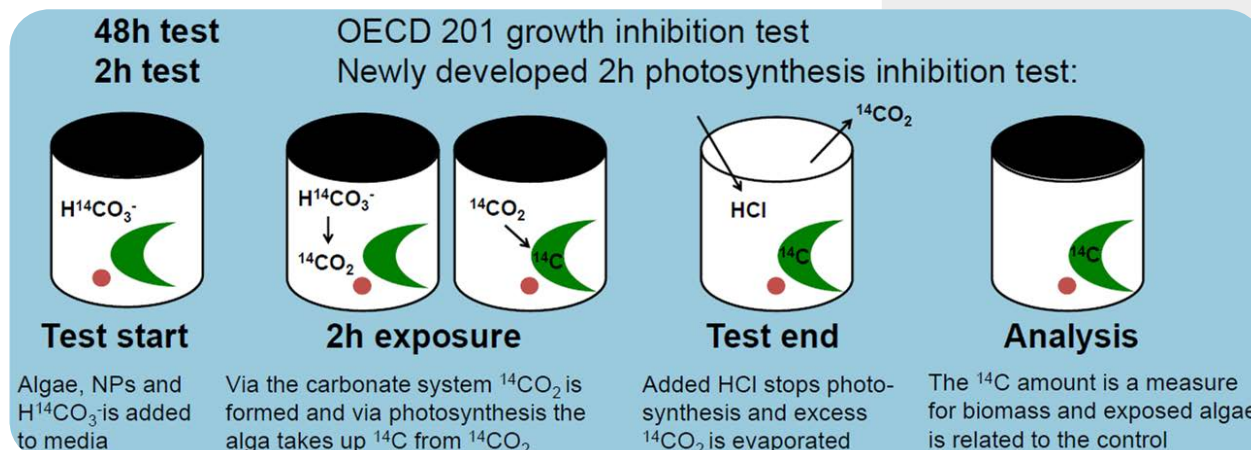
- Control exposure
- AND/OR
- Monitor/characterise exposure

Examples:

- Dispersion method matters!
- Media composition matters!
- Time matters!



Cupi, D., Hartmann, NB, Baun, A, 2015. Influence of pH and media composition on stability and nanoparticle ecotoxicity, *manuscript*

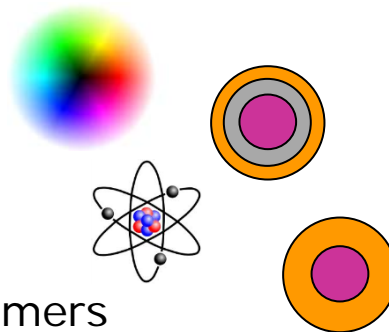


Exotoxicity testing of nanoplastics: some key challenges

- Detection, identification and quantification in the environment
 - Properties of environmentally weathered nanoplastics?
- Quantification of exposure in laboratory test
- Detection and quantification in test organisms

Options?

- Fluorescent dye
- Metal core (synthesis)
- C14 labelled?
- Chemical analysis of polymers
 - Pyrolysis GC-MS?
 - IR spectroscopy?



Thank you for your attention!

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Denisa Cupi, DTU Environment

Sara Nørgaard Sørensen, DTU Environment

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